UPR Systèmes
de Cultures
Annuelles

Gene Flow, coexistence and environmental conservation :

Challenges for African agrisystems

Centre
de coopération
internationale
en recherche
agronomique
pour le
développement

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Atelier EU-ACP sur les enjeux des cotonniers GM en Afrique
Ouagadougou, 16-18 septembre 2008

Questions raised by the public

- **Concerns from NGO promoting Organic Cotton**
  - Co-existence between conventional and GM cotton is not possible. ..... (February 2002 : http://www.**helvetas**-mali.org **...**)
  - 0.1% detection threshold prefered to 0.9%
  - Impact of Bt introduction on Organic production systems ?
  - Is coexistence possible ?

- What is the environmental impact of cotton gene flow ?
  - In agrisystems and on wild cotton species or relatives.
  - EU references (Messéan *et al*. (2006))
  - Cirad experience in South Africa (2002-2005)

Organic Cotton Production

- ✓ 50,000 Tons (1/1000 of world production) in 2007
- ✓ African cotton (3,700 T, 7.4%)
- ✓ Attractive prices: - conventional = 160 FCFA/kg
  - organic = 274 FCFA/kg (+70%)
- ✓ Cropping under strict standards:

  No chemicals, No GMO's, 3 years of quarantine before marketing organic products.

What are the public fears?

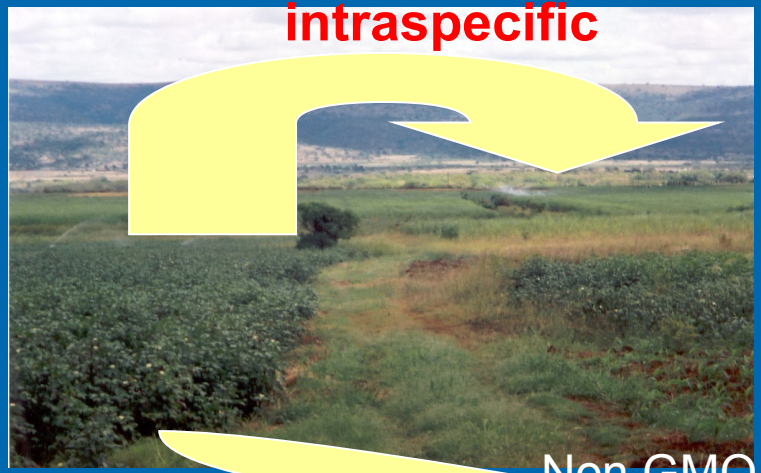
- Bt or RR “contamination” (mixture is a better word) in organic cotton: Fiber, Seed oil, cake…health impacts
- Reduced demand of cotton fiber on the EU market.
- Reduced demand of edible oil on the domestic African market.

Gene flow

pollen

intraspecific

interspecific



GMO

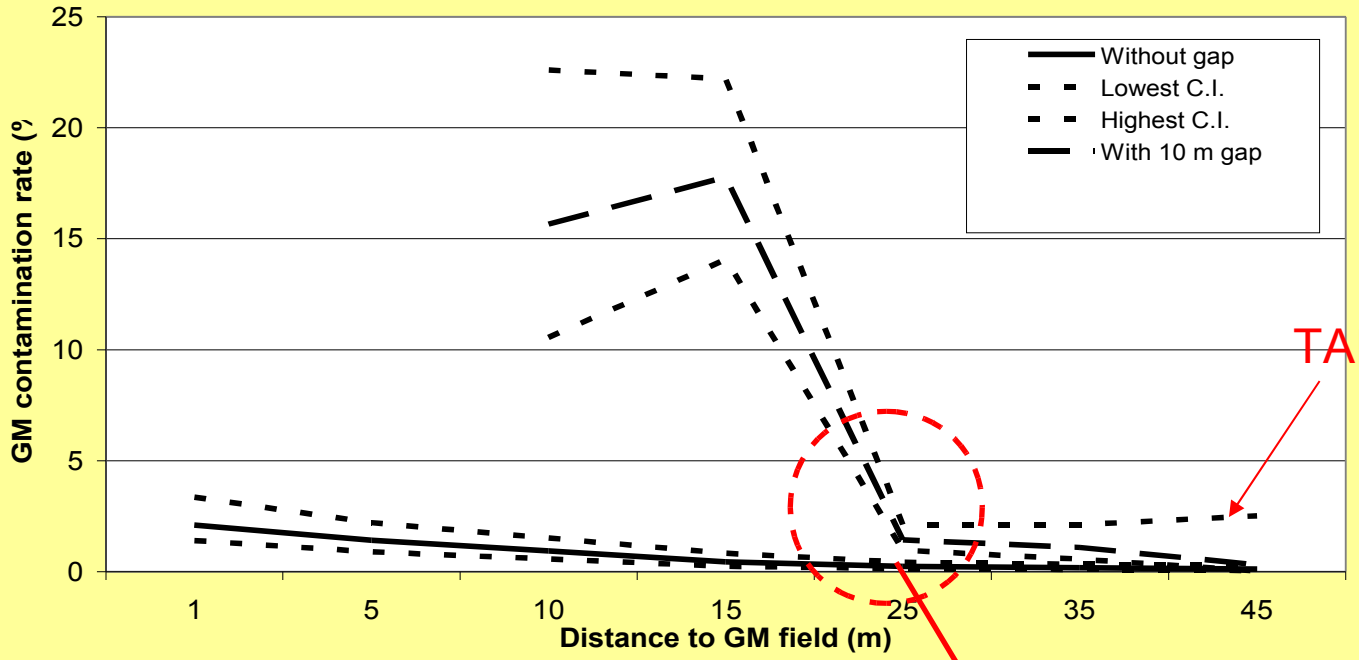
Non GMO

Related species

seeds

Pollen dispersal

Measurements (means) of out-crossing probability in adjacent cotton fields with and without a 10 m crop separation
Rustenburg,South Africa (2003-2005).



	Buffer *	
Separation	0.90%	0.10%
0 m	10 m	45 m
10 m	28 m	35 m

Are regulation thresholds objective?

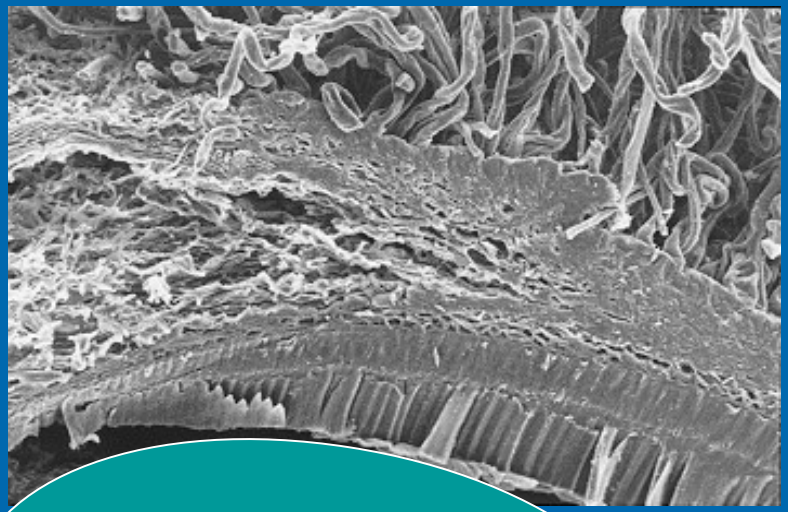
- Threshold for the presence of GM products = 0.9%
- Threshold for GM material in seeds= ??
- Extensible isolation distance

Example of maize in Spain:

- Regional Draft regulation: 25 m
- Civil opposition: 50 m
- Governmental draft regulation: 200 m
- Opponents 500-800 m….

- What purpose? Biologic or economic ?

Does Bt pollen “pollution” mean Bt products ?



Albumen 2n
+ n (Bt)

Zygote

n+ n (Bt)

Fibre

Seed tegument

} Maternal cells

✓An organic crop receiving Bt pollen still produces non-Bt fiber

✓No DNA or protein traces in cotton fiber ⟶ no detection possible

✓Refined Oil : no detection possible (traces)

Outcrossing to wild relatives

- 1. Sympatry – overlapping of the flowering period

- 2. Production of viable F1 interspecific hybrids

Cultivated Upland cotton

AADD , 2n = 52

Other genera within Malvaceae

Wild African cotton

AA , 2n = 26

F1 hybrids → steriles

Baranov (1930) , Gerstel (1953)

But existence of non reduced gametes in some F1...

Survivability of these plants and their offspring ?

Hybridization with other genera

- **Crossing compatibility**
- **Hybrid viability**
- ***Hibiscus esculentus*: one non-viable hybrid**

(Brown , 1947)

-In South Africa: 25 *Malvaceae* species in

cultivated cotton area

UNLIKELY

Potential adverse effects of transgene introduction in wild species

- Introduction of Bt theoretically reduces refuge potential of wild host plants.
- HT trait introduction has no impact in absence of selection pressure with specific herbicide.
- Cotton can be consider reasonably as a non weedy species.

Gene flow through SEED SPILLING

Cotton seeds (even felt down raw cotton can germinate on the ground (0.4-1% survival)

Volunteers

Ferals: 73% RR and 27 % Bt

Other risks of admixture

- ✓Unintentional: from picking up to ginning process
- ✓Intentional: conventional or GM cotton sold as organic in order to get premium.

Reducing gene flow in small-scale farming systems

- A good isolation needed with field separation (>15 m) and cotton buffers (>10 m).
- ✓ But existence of small fields (1-3 ha)
- ✓ Cost of non GM buffers (same as refuges)
- ✓ Reduced feasibility in small scale farming condition.

- Control of volunteers and feral plants (almost never done).
- Strict selective picking and storage
- Cleanness at every level of the chain.

Field pattern in small-scale farming communities of Makhathini Flats (RSA)

Non-Bt fields

Bt fields

Bush

Coexistence ?

Accepting fiber develops from « Bt-DNA-Free cells »

Radical standpoint : No acceptance

✓Fiber marketed under Organic label

✓Seed put towards GM commodity

✓Separated cotton production at a regional scale.

Isolated seed production for multiplication purposes

No or few additional costs

Increased production costs

Conclusion

- Seed multiplication: isolated areas and separate seed production process
- Rational field coexistence: control of volunteers, regrouping fields.
- Separated cotton market and ginning process in the time scale: 3 waves

- 1- Organic
- 2- Conventional
- 3- GM

- High costs due to the separation of the organic cotton production may reduce sector profitability and increase the price of organic cotton fabrics.

MERCI…
Thank you

Bt and non-Bt cotton fiels in Makhathini Flats (Sout Africa, 2004)